

Observations of Jupiter during the Apparition of 1907-8.

By the Rev. T. E. R. Phillips. (Plate 1.)

The planet Jupiter was in "opposition" on 1908 January 29, in R.A. $8^h 45^m 0^s$, Dec. $18^\circ 52' 48''$ N., in the constellation Cancer. It was therefore very favourably placed for observers in the N. hemisphere, and between the latter part of September and the second week in June I was able to make observations on 126 occasions. These consisted of (1) notes and drawings of the forms and colours of the surface markings; (2) transit observations of spots in various latitudes across the central meridian of the illuminated disc; and (3) a few notes of special satellite phenomena.

All these observations were made with the $12\frac{1}{4}$ -inch equatorial reflector that belonged to the late Dr. W. A. Kibbler, which instrument was substituted in 1907 September for the $9\frac{1}{4}$ -inch reflector that had been in use for some years. The mirror of the Kibbler telescope—one of With's "reserves"—was re-figured a few years ago by Mr. Calver.

The following is a summary of the principal points of interest presented by the observations:—

(1) *Surface Markings.*

There were no very striking changes—at any rate at the beginning of the apparition—as compared with the planet's appearance in 1906-7, and the general aspect of the disc will be seen from the accompanying drawings.

The N. Equatorial Belt, which had broadened so remarkably the previous year, was at first still obviously triple, and for several months retained its distinctive colouring. The southern part of the belt was an intense brick-red, which merged gradually into orange and yellow in the central regions, and the narrow band which formed the north edge was blue. But during the latter part of the apparition the red and orange seemed to fade somewhat rapidly, and by the end of April the colour of the central portions of the belt had diminished to such an extent that the above-mentioned blue band seemed quite a separate object, and might well be taken for the N. Temperate Belt. It should be said that although there were still a number of dark streaks and white spots and gaps at the S. edge of the belt, they were generally far less conspicuous than in 1906-7. On the other hand, there were some interesting details in the middle portion, which (especially near the longitude of the Red Spot) exhibited rapid and somewhat puzzling changes.

The Equatorial Zone was again mottled with numerous light and dusky regions, and as usual was crossed by a series of delicate wisps.

The S. Equatorial Belt, as in 1906-7, was brownish on the whole. In some longitudes it appeared almost of a neutral tint, and there was still a purplish tinge at times over the portion of the belt in and near the *f.* "shoulder" of the Red Spot bay. As the apparition advanced, the white rift dividing the belt longitudinally became remarkably sinuous, and swollen into a series of rather large and very brilliant spots.

The Great Red Spot was at first by no means a really difficult object, and appeared as a dusky grey ellipse with rather pointed ends, and a somewhat lighter central region. But later, after the conjunction of the great S. tropical disturbance had begun, it seemed to lose its clearness of outline, and to become indistinct and misshapen, as if confused and distorted by overlying clouds. White spots were also seen at its *p.* and *f.* ends. A similar effect was observed at the previous conjunction of 1906, though the complete oval form of the hollow at such times is always conspicuously displayed. It is worth noting that the region of the S. Equatorial Belt near the *p.* "shoulder," which has for many years been marked by a widening of the longitudinal rift, and (particularly in 1906-7) by an extreme faintness of the S. component of the belt, during the past apparition became very dark and strong like the region about the *f.* "shoulder."

The Great S. Tropical Disturbance has lost none of its characteristic features, and continues to be one of the most interesting of the surface markings. Just at the beginning of the observations it seemed to have become fainter, and to be breaking up into dusky wisps stretching across the zone, but this was only a temporary appearance, and has been observed on sundry previous occasions. The *p.* end of the disturbance overtook the *f.* "shoulder" of the Red Spot hollow just before the middle of January 1908, and it is noteworthy that on this occasion the edge of the dark matter was observed for the first time to encroach on the *S.f.* margin of the Red Spot itself, and where it joined the S. Equatorial Belt, to extend distinctly some little distance beyond the great "shoulder," which was now and then clearly seen through it. In length, the dark region increased from a little less than 70° at the beginning of the apparition to $100^\circ \pm$ at the end of May, and thus exceeded all previous measurements.

The N.N. Temperate Belt and the *N. Polar Regions*, which had been bluish-purple in 1906-7, were again brown, the N.N. Temperate Belt even showing at times a decided tinge of red.

The S. Temperate Belt was bluish-grey, and the region from the S.S. Temperate Belt to the S. Pole grey.

(2) *Rotation Periods.*

As in previous years, a good deal of attention has been given to the drift of spots, and the determination of their rotation periods. About 1600 transit observations of various markings over the central meridian were secured during the past apparition, and I

have to acknowledge the assistance of Miss Church of Ashtead in the somewhat heavy work of their reduction. On plotting the observations it was found that just over 100 separate objects had been observed sufficiently well to give results that are reasonably reliable; and where gaps in the series or other difficulties have caused some uncertainty, the fact has been duly noted in the remarks which follow. The spots are obviously too numerous to give in detail, but the mean values of their periods will be found in the accompanying table.

Table of Rotation Periods.

Objects observed.		No. of Spots.	Mean No. of Observations.	Mean No. of Rotations.	Rotation Period.		
					h	m	s
Spots in South Polar Regions . . .		2	6	124	9	55	24.3
South South Temperate spots . . .		8	5.5	158	9	55	4.9
Bright and dark spots on and at S. edge of South Temperate Belt . . .		21	12	345	9	55	20.4
Great South Tropical Disturbance.	<i>Preceding</i> white spot	1	13	632	9	55	16.3
	<i>Preceding</i> end of dark matter at S. Temp. Belt	1	25	632	9	55	16.3
	<i>Preceding</i> end of dark matter at S. Equatorial Belt	1	26	632	9	55	16.3
	White spot in S. Tropical Disturbance	1	7	380	9	55	22.4
	<i>Following</i> end of dark matter at S. Temp. Belt	1	25	632	9	55	22.5
	<i>Following</i> end of dark matter at S. Equatorial Belt	1	33	632	9	55	22.7
	Following white spot	1	20	494	9	55	22.2
	Mean of <i>p.</i> and <i>f.</i> ends of the Disturbance	...	...	...	9	55	19.4
Great Red Spot Hollow		1	43	603	9	55	40.7
White spots in middle of S. Equatorial Belt		3	6	254	9	55	33.7
White and dark spots at and near N. edge of S. Equatorial Belt and on Equatorial Zone		42	15	391	9	50	26.7
White and dark spots at S. edge of N. Equatorial Belt		7	6	245	9	50	33.0
Dark spots in and at N. edge of N. Equatorial Belt		5	15	359	9	55	22.0
Spots on N.N. Temperate Belt		5	7	255	9	55	37.4
Spots in N. Polar shading		2	4	177	9	55	42.3

Remarks on the Rotation Periods.

Almost all the results given in the above table indicate a slight increase of velocity as compared with the corresponding values for last year, and in some instances the objects have been so well observed in both years as to leave no room for doubt as to the reality of the acceleration.

Spots in S. Polar Regions.—The observation of markings in these high latitudes is a matter of considerable difficulty, partly in consequence of foreshortening, and partly because of the slowness of their linear motion.

The transit times secured are therefore not quite so accordant as could be wished, and the rotation period given in the table cannot be regarded as more than approximate.

Spots on and at S. edge of S. Temperate Belt.—In 1906–7 the S. temperate current was drifting at a perceptibly slower rate than usual. In the last apparition a slight acceleration seems to have set in.

The Great South Tropical Disturbance.—As in former years, the periods of the *p.* and *f.* ends were not the same, but whereas in 1906–7 the motion of the *f.* end was the more rapid of the two, the reverse was the case in 1907–8, when the difference of rate amounted to rather over 6^s. The rate of the *p.* end, however, showed some striking variations. Thus from September 23 to January 20 the period was 9^h 55^m 16^s·8; from this date to March 1 it was only 9^h 55^m 5^s±, and from March 1 to the last observation on June 10, 9^h 35^m 22^s·3. These values all refer to the marking at the S. Equatorial Belt, and the very quick motion of the intermediate period occurred during the time that the dusky material was passing from the *f.* to the *p.* side of the Red Spot Hollow. It will doubtless be remembered that an analogous acceleration has taken place at former conjunctions of the S. Tropical disturbance with the Red Spot (see *Monthly Notices*, June 1907, pp. 525 and 526, and B.A.A. Report of the Jupiter Section, vol. xvi., part I, pp. 10 and 19); only, on this last occasion the apparent transference of dark matter across the bay was seemingly very much slower than is usually the case. There is some doubt as to the exact date when it first arrived at the *p.* “shoulder”; and if it was earlier than March 1, the rotation period during the transference would have to be considerably shortened, but there can be very little doubt that the movement was slower than on previous occasions. Still, a study of the material now accumulated clearly shows that at the time of conjunction, whichever end happens to be immediately concerned, the apparent motion of the dark material invariably becomes strikingly accelerated, and that it is during its passage across the bay that the disturbance attains its maximum length.

The Great Red Spot.—Many of the variations that have occurred in the motion of this object during the last five years have been obviously related to the movements of the Great S.

Tropical Disturbance. Thus, at each conjunction the Red Spot has diminished its longitude, and at the end of the conjunction of 1906 the displacement amounted to about 15° . After conjunction, the Red Spot appears to drift slowly back again, and in May 1907 the longitude was rather over 24° . A fresh acceleration then apparently set in, as, when the planet reappeared in the morning sky, early observations made at the end of September and beginning of October 1907 gave a longitude of about 20° or rather less. But the acceleration was only of a temporary character, and the longitude again gradually increased to about $24^\circ.5$ in the following January and February, when, for the fourth time, the Great S. Tropical Disturbance came into conjunction with it. Somewhat tardily the Red Spot then began to swing back, and when the observations ceased at the beginning of June the longitude was apparently rather less than 20° .

White Spots in middle of S. Equatorial Belt.—A large number of these objects made their appearance during the apparition as swellings of the white rift which divides the belt longitudinally. But they exhibited many changes, and were not easy to follow and identify. Only three have been considered sufficiently well observed to be selected, and of these, two had a period of about $9^h 55^m 27^s.5 \pm$, and the other—a very prominent object near the p. “shoulder” of the Red Spot bay—a period of $9^h 55^m 46^s.1$.

White and Dark Spots at and near N. edge of S. Equatorial Belt and on Equatorial Zone.—As usual, the equatorial spots exhibited some marked irregularities of motion, and those in longitudes $30^\circ \pm$ to $180^\circ \pm$ (System I.) were drifting a good deal more rapidly than those elsewhere during the period covered by the observations. The mean rate, however, has differed but little during the past few years.

White and Dark Spots at S. edge of N. Equatorial Belt.—These features were not nearly so conspicuous as during the previous apparition, and my observations of them are by no means so numerous or so satisfactory as I could wish. In some instances the identifications may be in error, but the period given in the table is *probably* not far from the truth.

Spots in and near N. edge of N. Equatorial Belt.—As already mentioned, some of the objects in the N. Equatorial Belt underwent rapid changes, which it was very difficult or impossible to follow. But all doubtful cases have been discarded, and those selected have been thoroughly well observed. The period seems a good deal shorter than that usually exhibited by N. Tropical spots, and the best observed and most prominent of all—a dark well-defined object at the S. edge of the blue N. component of the belt, in $\lambda 111^\circ$ on the date of opposition—moved uniformly throughout, with a rotation period of only $9^h 55^m 17^s.6$.

Spots on N.N. Temperate Belt.—These spots have recently shown a decided acceleration. They usually have a period which is considerably longer than that of the adopted zero-meridian of System II. ($9^h 55^m 40^s.632$), and I can only recollect one object

—a dark spot which in 1899 was followed for several months with a mean period of $9^h 55^m 32^s \pm$ —with a rate similar to those of some of the spots lately observed. The identifications appear to be correct.

Spots in N. Polar shading.—As is the case with the spots in the S. Polar shading, a good deal of difficulty attends the observation of markings on this part of the disc. The positions are not very accordant, and the result given in the table cannot be regarded as having much weight.

(3) *Satellite Phenomena.*

Only three phenomena of special interest were observed, viz. occultations of the first satellite by the second on three consecutive Saturdays. The following are the details of the observations:—

1908 March 14.

1st contact $8^h 41^m$.

Quite round $8^h 42^m.7$ to $8^h 44^m$.

Last contact $8^h 45^m.3$.

Definition bad, so times were somewhat uncertain, but no doubt about the completeness of the occultation. Power used 298.

1908 March 21.

In contact when first noticed at $10^h 50^m.5$.

Quite round $10^h 52^m$.

Elongated $10^h 53^m$.

Last contact $10^h 55^m$.

Definition bad. Power 298.

1908 March 28.

1st contact $12^h 0^m$.

Quite round from $12^h 3^m$ to $12^h 4^m.5$.

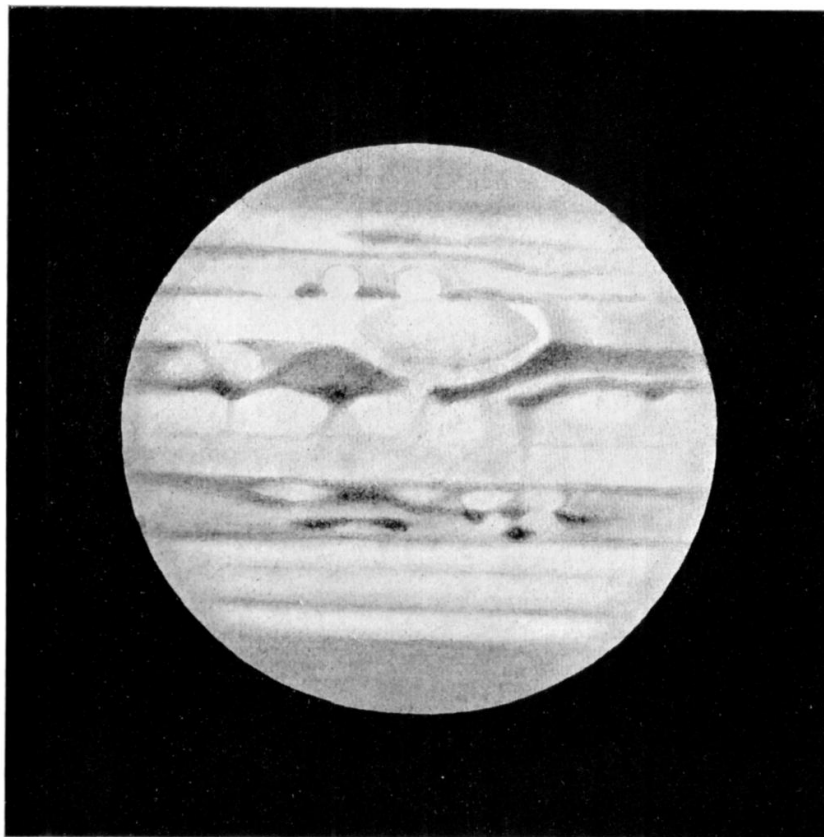
Last contact $12^h 7^m$.

Planet getting low, and definition very bad. Impossible to get anything like a sharp image, and could not use a higher power than 232. Times of contact probably erroneous owing to bad seeing.

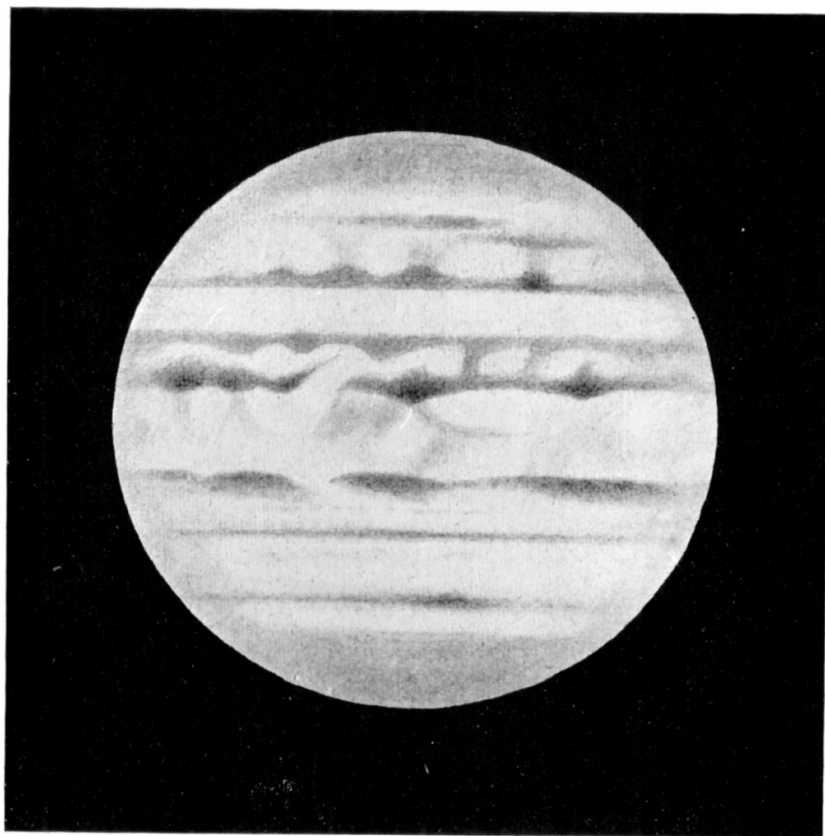
Miscellaneous Notes.

On 1908 Feb. 10, between $6^h 25^m$ and $16^h 35^m$, I observed for the first time rather more than a complete rotation of the planet. The f. "shoulder" of the Red Spot bay was seen in transit across the central meridian twice, and altogether about ninety transits of various markings were secured, and sundry other notes and drawings made. Definition, however, which had been good at first, became very bad towards the close of the observations.

On Feb. 27, Jupiter occulted a star, which is probably B.D. + 19° , 2044, mag. 9.4. When observations were begun at about



1908 Jan. 11.
 $\lambda = 50^\circ \pm$ System I.: $17^\circ \pm$ System II.



1908 Feb. 27.
 $\lambda = 302^\circ \pm$ System I.: $270^\circ \pm$ System II.

DRAWINGS OF JUPITER.—REV. T. E. R. PHILLIPS.